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ABSTRACT

Researchers construct a cost of education index and, using Missouri data, estimate differences across school districts in the cost of teachers, administrators, and transportation services. Components of the conceptual framework for the index include salaries, variables within a district's control (such as personnel characteristics or the number of pupils transported), and variables not within district control (such as labor market characteristics, road conditions, or pupil density). A formula for the index is determined, based on these components and the relative importance of personnel and transportation costs in district budgets. Equations for costs are then estimated from 1975-76 Missouri data, based on variables that include (1) personnel education, experience, position, subject area, and educational level; (2) district demographic, economic, and climatic characteristics; and (3) numbers, density, and distances of pupils transported. Computation of the overall cost of education index indicates that Missouri's urban and suburban districts pay above-average costs, while its rural districts pay below-average costs. The researchers briefly examine the stability of the index over time, simulate the application of the index to the state aid formula, and discuss the implications of the index for educational equity and efficiency. (RW)

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PAPERS IN EDUCATION FINANCE

Paper No. 9

GEOGRAPHIC COST-OF-EDUCATION DIFFERENTIALS

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ABSTRACT

The cost of obtaining education inputs generally will vary among school districts in a state. Educators and state legislators increasingly are concerned over whether and how to compensate school districts for variations in education costs. This paper reports on some empirical estimates of differences in the costs of teachers', administrators', and transportation services across school districts within the State of Missouri. Based on these estimates, an overall cost-of-education index is computed, the patterns of cost variation are examined, and the impact on state aid allocations is determined. In addition some conclusions are drawn regarding the stability of the index over time and various other aspects related to the implementation of a cost index as part of school finance policy.

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INTRODUCTION

At the center of much of the recent debate over school finance reform is the issue of equity. Judicial and legislative attempts have been initiated in many states to create a more equitable school finance system. The purpose of this reform has been to reduce or eliminate the differences in the quality of educational services offered across local school districts or at least make expenditures less dependent on local district wealth.

There are three kinds of disparities that must be dealt with in equalizing state aid to education: disparities due to differences in wealth (or local fiscal capacity), pupil-need, and educational costs. Most of the new state school finance plans have concentrated on property wealth equalization. Many of these new plans also include pupil weighted systems or expanded categorical programs to provide additional aid for varying pupil needs. Few states, however, have been able to consider ways to provide equalization for the differences in educational costs among local school districts; no state has developed a cost-of-education index for its local school districts.[1]

As an initial effort to evaluate and measure variations in the costs of educational services, this paper reports on a project to develop an index which accounts for variations in the cost of school personnel (i.e., teachers and administrators) and transportation services across local school districts in the State of Missouri. Taken together, expenditures on school personnel and transportation services account for over 77 percent of current school district budgets in Missouri. The ultimate purpose of such a cost index is to adjust the level of state aid to local school districts in order to equalize the purchasing power of educational dollars across the state.

The conceptual framework employed in the analysis of variations in personnel and transportation costs is presented in Section I. The calculation of the cost-of-education index based on these components of costs is demon-

scrated in Section II. Section III contains a discussion of the estimation of the behavioral equations for personnel salaries and transportation expenditures. Section IV focuses on the actual computation of the cost index and an examination of the patterns of cost variation across various categories of school districts and regions of the state. Section V deals with the implications of the cost index for the allocation of state aid and presents some evidence on the stability of the index over time. Some concluding remarks are presented in Section VI.

I. THE CONCEPTUAL FRAMEWORK

Costs of School Personnel. Variations in earnings, whether in the public or private sector or across different occupations, may be attributed to variations in the characteristics of the individual and of the work place. In general, better educated, more experienced, and more intelligent or capable workers will receive higher pay, ceteris paribus. Similarly, an occupation or place of employment exhibiting certain unattractive features (e.g., particularly hazardous work) will tend to be associated with higher earnings, holding worker characteristics constant.

Viewed in this context, labor market transactions involve a mutual exchange of worker characteristics and attributes of the work environment. In the market for school personnel, school decision makers are purchasing the characteristics of teachers and administrators while selling the attributes of classrooms, schools, districts, and the regions in which they are located. On the other side of the market, individual school personnel are selling their personal characteristics while purchasing the attributes of the school environment. In equilibrium each side of the market selects an optimal location in space characterized by a set of personal attributes and working conditions.

The resulting empirical relationship between salaries, personal characteristics, and working conditions is referred to as the market price schedule for school personnel and is intended to reveal implicit market prices for each element in the exchange package which characterizes transactions in this labor market.

Given the immobilities which appear to characterize the markets for public school personnel, one might question whether the conceptual framework specified above is an adequate representation of reality. One response to this concern is that at least in part this is an empirical issue. One can investigate the relationship between salaries, personal characteristics, and working conditions and determine if it yields results which appear consistent with our expectations and with certain restrictions imposed by the theoretical structure. Previous work on the determinants of teachers' salaries seems to reveal patterns which are both consistent with expectations and restrictions of the theoretical structure (e.g., see Antos and Rosen [1]).

A second concern is more contemporary in nature and relates to the apparent surplus which characterizes at least the market for school teachers. Does this representation of the teachers' market account in any way for the apparent disequilibrium? Again the answer lies in examination of the empirical results. Disequilibrium presumably affects not only the overall market price of teachers, but also the implicit prices associated with the set of attributes which characterize each labor market exchange. Therefore, empirical analysis of variations in personnel salaries may tend to automatically reflect this disequilibrium in the market. Suppose the surplus has had the effect of making available to districts a rather large reserve of teachers with relatively high levels of certain ability traits (e.g., verbal proficiency among teachers). One would expect to find that the premium paid for verbal ability in the market would decline. Similarly, one may find teachers becoming less

averse to teaching high proportions of minorities if the overall level of wages is above the equilibrium level. In each of these cases, implicit prices for these attributes will not be revealed by the analysis. Nevertheless, the observed empirical relationship still reflects the current circumstances facing districts in the market and, therefore, may serve to help identify differential costs of school personnel across local school districts.

For the purpose of analyzing cost differentials, one can divide the determinants of personnel salaries into two categories: (1) those that are endogenous and (2) those that are exogenous to local school district decision makers. The endogenous factors include the personal characteristics (e.g., educational preparation, professional experience, and sex) and those aspects of working conditions (e.g., class size) that are within the control of local decision makers. The exogenous factors include characteristics of the district that reflect its relative attractiveness as a place to work and the conditions in the local labor market within which the district is located.

It is, in fact, the differentials in the salaries of school personnel attributed to the exogenous factors that are of concern to educational policy makers in the determination of variations in costs of educational services. Given the set of endogenous working conditions that characterize a particular school district, the exogenous factors affect the supply of, and hence the salaries paid to, school personnel with a given set of personal characteristics. Therefore, the value of a dollar of state aid, as well as of local tax revenue, varies across school districts depending upon the conditions that determine the local supply of school personnel.

Transportation Costs. To assess the costs of transportation services, one can use a similar approach to that used to assess the variations in personnel costs. Variations in expenditures on transportation services can

be separated into endogenous and exogenous components. For example, the number of pupils transported by private carriers and the mileage traveled per pupil transported (once controlling for pupil density) may be regarded as endogenous to district decision making. However, pupil density, road conditions, and costs of living and insurance are likely to be outside district control. Given the behavioral equation for transportation expenditure, an index of transportation costs would then separate out the extent to which spending variations on transportation services across school districts are outside the control of local decision makers.

II. DETERMINATION OF THE COST-OF-EDUCATION INDEX

Formally, the market price schedule for school personnel may be specified as follows in log-linear form:

$$\ln SAL_i = \alpha + \beta E_i + \gamma X_i + u_i \qquad (1)$$

where SAL_i = the annual salary of individual i,

E_i = the vector of endogenous personal characteristics and working conditions associated with individual i,

X_i = the vector of exogenous determinants (i.e., district and labor market characteristics) of the salary of individual i,

and u_i = the random disturbance term.

The index of personnel costs is based on the variations in salaries across districts caused by the variables contained in the vector X while the variables included in E are held constant. In order to make this calculation of cost differentials, it is necessary to choose some standard set of endogenous characteristics (e.g., the average values across all districts in the sample). This approach will permit determination of how much more or less one district pays than another for the same personal characteristics given any set of endogenous working conditions.

For the present analysis, the mean values across the sample districts shall be taken as the standard of comparison for computation of differential costs. Let the bars over the variables below denote these mean values. Personnel cost differentials in any district j may then be expressed as follows:

$$\ln SAL_j - \ln \overline{SAL} = (\alpha + \beta\overline{E} + \gamma Y_j) - (\alpha + \beta\overline{E} + \gamma\overline{X}).$$

Rearranging terms one can then determine a salary index for personnel costs given by the expression,

$$SALINDEX_j = SAL_j/\overline{SAL} = EXP[\gamma(X_j - \overline{X})] \qquad (2)$$

An index of transportation costs would be calculated in exactly the same way as just described for the salary index.

In order to calculate an index of educational costs that can be applied to total current expenditures, it is necessary to weight the salary index determined for each category of school personnel and the transportation cost index by the respective proportion of the average school district budget that is allocated to each expenditure category. In this context we are simply applying the concept of a standard "market basket" to the purchase of school inputs. In this way the quantity and characteristics (i.e., "quality"?) of school services are held constant to determine cost variations associated with supply factors. In the empirical analysis presented below, two categories of school personnel are identified: teachers and administrators. The salary indices for teachers and administrators are denoted TSALINDEX and ASALINDEX, respectively. The transportation cost index is denoted by TRANINDEX. The percentage of current school budgets allocated, on average, by Missouri school districts to teachers, administrators, and transportation services are 63.53%, 8.56%, and 5.17%, respectively. A cost index for district j is then calculated as follows:

$$\text{COST INDEX}_j = (.6353 \cdot \text{TSALINDEX}_j) + (.0856 \cdot \text{ASALINDEX}_j) + (.0517 \cdot \text{TRANINDEX}_j) + .2274 \quad (3)$$

The .2274 is included simply to account for the remainder of the school district budget for which no separate index of cost variation has been calculated.

It should be noted that it may not be appropriate to apply a constant budget weight to the salary and transportation indices in order to calculate the overall cost index. Differences in technology, taste, or costs across different kinds of districts (e.g., urban, suburban, or rural) may tend to alter combinations of inputs employed. Unfortunately, no data were immediately accessible to examine these alternative weightings. However, such adjustments of budget weights must necessarily be examined before a cost-of-education index can be implemented.

III. DETERMINANTS OF PERSONNEL SALARIES AND EXPENDITURES ON TRANSPORTATION SERVICES

The data used for the analysis of personnel salaries include a random sample of individual teachers and administrators employed by local school districts in the State of Missouri during the 1975-76 school year. Information on personal and district characteristics were obtained from the Missouri Department of Elementary and Secondary Education (DESE), survey questionnaires sent to samples of school personnel, and the Census. Data for analysis of transportation expenditures were derived from DESE files, the Census, and the National Climate Center and include all districts in the state providing transportation services. Symbols and definitions for all variables are presented in the Appendix.

Salaries of Personnel. Data on personal characteristics include educational preparation, years of experience, job description (i.e., level of instruction and type of teacher or administrator), sex, number of class hours per week, and whether the teacher was confined to geographic location by spouse's employment. Income of families residing in the district is also included in the analysis to capture any unmeasured characteristics of school personnel. This assumes that districts with higher income families will demand better "quality" teachers.[2]

The estimates for the teachers' and administrators' salary equations are reported in Tables 1 and 2, respectively. Each of these equations explains over 85% of the variance in salaries, and the estimated coefficients correspond well to intuitive expectations and are consistent with the results of previous studies. More highly educated individuals receive higher salaries, ceteris paribus. Increased experience, both total years and within the present district, appears to result in higher salaries, but the rate of increase tends to fall with experience. Teachers confined by spouses' employment appear to earn less, presumably due to the restrictions in mobility which would otherwise permit individuals to seek more advantageous opportunities. Males tend to earn more than females in both markets with the differential being twice as large for administrators as for teachers. For those familiar with the structure of school district salary schedules, which presumably pay any teachers with equivalent educational preparation (years of schooling or degree level) and professional experience the same salaries, this result may appear anomalous. Nevertheless, these two statements are not at all inconsistent with one another.

TABLE 1

DETERMINANTS OF TEACHERS' SALARIES
IN MISSOURI SCHOOL DISTRICTS, 1975-76:
AN ALTERNATIVE SPECIFICATION[a]
[DEPENDENT VARIABLE = LOG_e (TCHR SAL)]

Explanatory Variables (1)		Estimated Coefficient (2)	Absolute t-Ratio (3)	% Effect on Tchr's Salaries[b] (4)	Mean Value	Standard Deviation
(1)	EDUC NO BA	-0.11544	2.97	-10.902	0.0066	0.0810
(2)	EDUC BA	-------	----	-------	------	------
(3)	EDUC 15-29 GRAD HRS	0.03649	3.39	3.72	0.[illegible]	0.2944
(4)	EDUC 30-44 GRAD HRS	0.02266	1.79	2.29	0.2442	0.4299
(5)	EDUC 45-60 GRAD HRS	0.04021	2.31	4.10	0.0539	0.2260
(6)	EDUC 60 OR MORE GRAD HRS	0.08225	4.42	8.57	0.0528	0.2238
(7)	EDUC MA	0.11243	9.33	11.90	0.3740	0.4841
(8)	EDUC ED SPEC CERT	0.16495	4.05	17.93	0.0066	0.0810
(9)	EDUC DOC	0.06402	1.14	6.61	0.0033	0.0574
(10)	EXP TOTAL YRS	0.01836	10.17	1.85	10.4917	8.3293
(11)	$(EXP\ TOTAL\ YRS)^2$	-0.00039	8.12	-0.08	175.2112	270.1040
(12)	EXP PRESENT DIST	0.01434	6.35	1.44	7.4125	6.0257
(13)	$(EXP\ PRESENT\ DIST)^2$	-0.00028	3.65	-0.06	91.2145	149.4675
(14)	MATH-SCI TCHR	-0.01843	2.00	-1.83	0.1430	0.3503
(15)	PHYS EDUC TCHR	0.03484	2.60	3.55	0.0583	0.2344
(16)	BUS EDUC TCHR	-0.02833	2.01	-2.79	0.0506	0.2193
(17)	VOC EDUC TCHR	0.06291	4.44	6.49	0.0539	0.2260
(18)	ELEM TCHR	-------	----	------	-------	-------
(19)	CONFINED TO GEOG. LOC.--YES	-0.02004	2.97	1.98	0.3784	0.4853
(20)	CONFINED TO GEOG. LOC.--NO	-------	----	------	-------	-------
(21)	SEX -- MALE	0.02602	3.43	2.64	0.3267	0.4693
(22)	SEX -- FEMALE	-------	----	------	-------	-------
(23)	LOG_e(FAMILY INCOME)	0.24948	11.05	0.249	9.3328	0.2440
(24)	PERCENT BLACK PUPILS	0.00073	2.27	0.073	7.3374	17.4189
(25)	PERCENT REMED. READ. PUPILS	0.00149	1.99	0.149	7.5206	5.1310
(26)	LOG_e(DIST SIZE)	0.18776	7.44	0.19	8.4003	1.4899
(27)	$[LOG_e(DIST\ SIZE)]^2$	-0.00933	6.10	0.02	72.7819	25.1470
(28)	LOG_e(DIST. DENSITY, REGION)	0.06411	4.22	0.064	-4.5114	0.3250
(29)	LOG_e(POP. DENSITY, COUNTY)	-0.01797	3.38	-0.018	.0095	0.8912
(30)	LOG_e(PRICE AGRI. LAND)	0.04430	4.49	0.044	5.8983	0.6828
(31)	CONSTANT TERM	5.85715	----	------	-------	-------

R^2 = .86 F(26,882) = 214.4 STANDARD ERROR = 0.09083

Sample Size = 909 LOG_e(TCHR SAL): Mean = 9.2619, Std. Dev. = 0.2422.

[a] The index of teachers' salaries calculated from this equation is based on variables 24 through 30. All other variables are held constant.

[b] The figures presented in Column 4 represent the percentage effect on teachers' salaries for the dummy variables and elasticities for the variables in LOG_e or percentage form. For the variables reflecting experience (EXP), the number in Column 4 reflects the percentage effect on salaries of each additional year of experience. For the squared terms, Column 4 reflects the percent rate of change in the percentage effect. For experience, the percentage increase in salaries is 1.85 which decreases at a rate of .08 percent per year.

TABLE 2

DETERMINANTS OF ADMINISTRATOR SALARIES IN MISSOURI SCHOOL DISTRICTS, 1975-76: [DEPENDENT VARIABLES = LOG_e (ADMIN SAL)][a]

Explanatory Variables (1)		Estimated Coefficient (2)	Absolute t-ratio (3)	% Effect on Admin. Salaries[b] (4)	Mean Value	Standard Deviation
(1)	EDUC BA	-----	-----	-----	-----	-----
(2)	EDUC 60 OR MORE GRAD HRS	0.02011	2.08	2.03%	0.2660	0.4421
(3)	EDUC MA	0.09810	5.83	10.31	0.8105	0.3921
(4)	EDUC ED. SPEC. CERT.	0.12972	5.60	13.85	0.0639	0.2447
(5)	EDUC DOC	0.18573	7.19	20.41	0.0440	0.2052
(6)	EXP TOTAL YRS	0.01732	10.62	1.75	17.9634	9.1489
(7)	EXP $(TOTAL\ YRS)^2$	-0.00030	7.95	-0.06	406.2963	378.3722
(8)	EXP PRESENT DIST	0.00315	4.46	0.32	11.7759	8.5417
(9)	ELEM PRIN OR ASST PRIN	-----	-----	-----	-----	-----
(10)	JR HIGH SCH ASST PRIN	-0.02742	1.69	-2.70	0.0618	0.2409
(11)	JR HIGH SCH PRIN	0.09482	6.83	9.95	0.0859	0.2803
(12)	HIGH SCH ASST PRIN	0.02977	2.09	3.02	0.0806	0.2724
(13)	HIGH SCH PRIN	0.16083	13.91	17.45	0.1717	0.3773
(14)	ELEM SUPV	-0.14484	9.38	-13.48	0.1110	0.3143
(15)	JR HIGH SCH SUPV	-0.02244	0.56	-2.22	0.0084	0.0912
(16)	HIGH SCH SUPV	-0.06928	2.85	-6.69	0.0293	0.1688
(17)	VOC EDUC SUPV	0.010790	2.38	11.39	0.0063	0.0791
(18)	GENERAL SUPV	-0.01804	0.95	-1.79	0.0408	0.1980
(19)	ELEM DIRECTOR	0.08267	4.68	8.62	0.0492	0.2164
(20)	CLASS HOURS	-0.00426	5.23	-0.43	2.2734	6.0440
(21)	SEX--MALE	0.06413	5.75	6.62	0.8052	0.3962
(22)	SEX--FEMALE	-----	-----	-----	-----	-----
(23)	LOG_e (FAMILY INCOME)	0.15845	6.46	0.16	9.0542	0.2970
(24)	ELEM DIST--YES	0.22388	7.99	25.09	0.0272	0.1628
(25)	ELEM DIST--NO	-----	-----	-----	-----	-----
(26)	LOG_e(DIST SIZE)	0.45661	15.91	0.46	8.3929	1.6661
(27)	$[LOG_e(DIST\ SIZE)]^2$	-0.02346	13.24	-0.05	73.2131	27.6972
(28)	PERCENT BLACK PUPILS	0.00034	1.19	0.034	10.6310	20.7431
(29)	LOG_e(DIST. DENSITY, REGION)	0.09618	5.07	0.096	-4.4981	0.3160
(30)	LOG_e(POP. DENSITY, COUNTY)	-0.01157	1.73	-0.012	4.1031	0.8528
(31)	LOG_e(PRICE AGRI LAND)	0.06951	5.99	0.070	5.9265	0.6763
(32)	CONSTANT TERM	5.84458	-----	-----	-----	-----

R^2 = .87 F(27,927) = 238.0 STANDARD ERROR = 0.10922

Sample Size = 955 LOG_e(ADMIN SAL): Mean = 9.6648, Std. Dev. = 0.3034

[a]The administrators' salary index calculated from this equation is based on variables 26 through 31. All other variables are held constant.

[b]The figures presented in Column 4 represent the percentage effect on administrators' salaries for the dummy variables and elasticities for the variables in LOG_e or percentage form. For the variables reflecting experience (EXP), the number in Column 4 reflects the percentage effect on salaries of each additional year of experience. For the variable CLASS HOURS, the number in Column 4 represents the percentage effects on salaries resulting from an increase of one hour of time spent teaching by administrators.

The positive salary differential for males may be interpreted as indicating that, for a given salary, a school district will be able to employ "better quality" females than male teachers, ceteris paribus, and/or that males tend to be attracted to, and hired by, higher paying school districts, on average. In both instances the result is associated with the higher opportunity costs that males have in the labor market (presumably due, at least in part, to discrimination).

Some recent developments in urban economics have focused on isolating particular sets of variables which reflect cost-of-living variations across regions. It has been suggested that cost-of-living differences across regions will be related to the cost of producing goods which are not traded across regions. Furthermore, differences in the cost of producing these local goods will be related to the cost of immobile factors of production such as land. For this purpose the price per acre of agricultural land within a county is used as a proxy for the base price of land.[3] The estimated coefficients indicate that a one percent increase in the base price of agricultural land leads to a .04% increase in teachers' salaries and approximately a .07% increase in the salaries of administrators.

Another specific factor affecting teacher and administrator costs is competition in the market. The number of districts per square mile in the labor market in which the district is located is used as a proxy for competition in the markets for school personnel.[4] The greater the number of districts per square mile within a particular region, the greater the intensity of competition for the services of school personnel and hence the higher the salaries. Estimates indicate that a one percent increase in the number of districts per square mile results in a .064 and .096 percent increase in the salaries of teachers and administrators, respectively.

Population density may be correlated with both disamenities (e.g., crowding) as well as the amenities (e.g., accessibility of consumption opportunities or cultural activities) of living in urban areas. The results of the present analysis reveal a negative impact of population density on wages suggesting that amenities correlated with population density are relatively more highly valued than the disamenities.[5]

Looking at characteristics associated uniquely with the district, one finds that pupil composition is a determinant of the relative attractiveness of local districts. The results indicate that districts with larger proportions of black pupils tend to have to pay relatively higher salaries to teachers as well as administrators, ceteris paribus, although the relationship in the administrator salary equation is not statistically significant. Similarly, districts with greater proportions of low ability pupils (i.e., as reflected by percent of pupils in remedial reading programs) tend to have to pay higher salaries to teachers, ceteris paribus. Ideally, one would have preferred a variable such as an average entry level (i.e., beginning of first grade) test score as an indication of the abilities of the students independent of district influences. Presumably, higher ability pupils will be easier to teach and will tend to be an attractive attribute of local districts. The variable, proportion of pupils in remedial reading programs, can be manipulated by school districts by improving the quality of educational programs or by assignment practices. For the purpose of this study, this variable has, nevertheless, been used as a proxy for student ability and is assumed exogenous to local districts.

The estimated relationship between salaries and district size appears to be quadratic in logs for both teachers and administrators. Moreover, the relationship reaches a maximum within the range of observed district sizes

for both types of personnel. Salaries of teachers increase with size up to about 23,500 pupils, decreasing thereafter, while administrators' salaries peak at about 17,000 pupils.

In metropolitan areas, collective bargaining appeared to have no impact on a district by district basis, but rather tended to raise teachers' salaries, ceteris paribus, in regions where larger proportions of teachers were covered by formal bargaining contracts (e.g., see Chambers [5]). The necessary data to extend this analysis of bargaining to rural areas were not available. It has been suggested that bargaining may be associated with some of the regional or urban variables included in the equation. It has been further suggested that if the state were to reimburse for gains from bargaining, this would destroy the incentives for school administrators to bargain. However, if bargaining effects are on a regional rather than district by district basis, incentives need not be altered. In particular, if the state reimburses districts based on a regional effect of bargaining, no one district would have the incentive to increase the bargaining gains of teachers since the increase in the average impact of bargaining across the region would be less than the associated increase in salary costs incurred by any one district. Hence, it may well be perfectly legitimate to include as an element of cost the regional impact of collective bargaining on teachers' salaries.[6]

Transportation costs. The regression equation used to estimate transportation costs is presented in Table 3. This equation explains about 95% of the variance in total transportation expenditures across local school

TABLE 3

DETERMINANTS OF TRANSPORTATION EXPENDITURES
IN MISSOURI SCHOOL DISTRICTS, 1975-76:
[DEPENDENT VARIABLE = LOG_e (TOTAL TRANS EXPEND)][a]

Explanatory Variables (1)	Estimated Coefficient (2)	Absolute t-Ratio (3)	% Effects on Trans. Expend. (4)	Mean Value	Standard Deviation
(1) LOG_e (MILEAGE/PUPIL)	0.44471	13.07	0.44	0.0785	0.5693
(2) LOG_e (AVG DAILY PUPILS TRANS)	0.73028	18.35	0.73	6.0709	1.1967
(3) LOG_e (CONTRACTED AVG DAILY PUPILS TRANS)	0.01275	3.65	0.01	2.3533	2.9443
(4) PERCENT URBAN POP. IN COUNTY	0.00090	2.14	0.09	35.4608	28.6405
(5) LOG_e (PUPILS/SQ. MI.)	-0.05469	3.17	-0.05	1.9719	1.4742
(6) LOG_e (DIST SIZE)	0.27981	6.23	0.28	6.4404	1.2572
(7) PERCENT CHG IN DIST SIZE	-0.00738	3.94	-0.74	-4.3724	9.0569
(8) LOG_e (INCHES OF SNOW)	0.07038	2.76	0.07	2.8880	0.4124
(9) ELEM DISTRICT--YES	-0.16739	3.60	-15.41	0.1869	0.3902
(10) ELEM DISTRICT--NO	-------	----	-----	------	------
(11) CONSTANT TERM	4.44136	----	-----	------	------

R^2 = .95 F(9,541) = 1,159 Standard Error = 0.23130

Sample Size = 551 LOG_e (TOTAL TRANS EXPEND): Mean = 10.8702, Std. Dev. = 1.0333

[a]The index of transportation costs calculated from this equation is based upon variables 2 and 4 through 10. All other variables are held constant.

districts. The positive impact of percent urban population in the county would seem to reflect the higher costs of transportation salaries as well as possible cost differences between urban and rural areas associated with vandalism, maintenance, and insurance. Pupils per square mile (i.e., pupil density) reflects dispersion of the student population within the school district. A one percent increase in pupil density would appear to reduce transportation costs by .05%. To see the magnitude of the impact of pupil density, consider an increase in pupil density equal to one standard deviation (i.e., approximately 28.64 pupils per square mile change) would reduce total transportation expenditures by about 7.7%, ceteris paribus. Districts in regions with greater amounts of snowfall also appear to incur higher transportation costs perhaps associated with greater frequency of repair, greater rates of deterioration, and poorer gas mileage. An increase of one standard deviation in snowfall (equivalent to about 9 inches of additional snow per year) would increase total transportation costs by about 2.9%. The elasticity of transportation costs with respect to district size is less than one, reflecting perhaps some economies of scale (i.e., total expenditures rise faster than district size) and the fact that the larger number of pupils per school, which tends to characterize larger districts, tends to reduce per pupil costs.

Once controlling for pupil density in a district, mileage per pupil would seem to be largely endogenous to district decision making. Districts providing more frequent bus service or more convenient service in other ways may well tend to drive greater numbers of miles per pupil transported. The number of pupils served by buses owned by private contractors appears to raise costs and should probably be regarded as endogenous to the district. It appears that private service is more expensive than service provided by

the district, although this may be illusory since some of the capital costs of transportation services may not be reflected explicitly by local districts even though these are in fact true costs to society of providing these services.

IV. EDUCATIONAL COST DIFFERENTIALS

Using the estimates of the teacher and administrative salary equations and of transportation costs contained in Tables 1, 2, and 3, and using the procedure outlined in equations 2 and 3, one can calculate an educational cost index. It should be noted, however, that this index of educational cost does not account for variations in the prices of school inputs other than teachers, administrators, and transportation. Further work needs to be done to account for the variations in cost of those items which make up the remainder of the educational budgets (e.g., salaries of non-certificated personnel and instructional materials).

The teachers' salary index is based on variables 24 through 30 in Table 1, the administrators' salary index is based on variables 26 through 31 in Table 2, and the transportation cost index is based on variables 2 and 4 through 10 in Table 3.[7] The cost-of-education index is then determined by combining the salary and transportation indices as shown in equation 3.

Table 4 presents descriptive statistics (i.e., means, standard deviations, minimums, and maximums) for the educational cost index across different categories of school districts (i.e., CENTRAL CITY AND SURBURBAN versus RURAL DISTRICTS) and districts located in different regions of the State of

TABLE 4

DESCRIPTIVE STATISTICS FOR THE EDUCATIONAL COST INDEX FOR MISSOURI SCHOOL DISTRICTS

District Category	Mean Value	Standard Deviation	Minimum	Maximum
ALL DISTRICTS	1.007	0.072	0.785	1.196
CITY AND SUBURBAN DISTRICTS	1.090	0.065	0.937	1.196
RURAL DISTRICTS	0.989	0.059	0.785	1.139
KANSAS CITY METROPOLITAN AREA	1.072	0.068	0.937	1.164
ST. LOUIS METROPOLITAN AREA	1.095	0.076	0.851	1.196
ALL OTHER REGIONS (excluding Kansas City and St. Louis metropolitan areas)	0.987	0.058	0.785	1.139

Source: Developed from estimates of behavioral equations in Tables 1, 2, and 3. Equation 3 describes the calculation of the cost index based upon these indices of teacher, administrator, and transportation costs.

Missouri (i.e., KANSAS CITY and ST. LOUIS METROPOLITAN AREAS versus ALL OTHER REGIONS OF THE STATE). In addition, these descriptive statistics are calculated for ALL DISTRICTS taken together.

The average value of the cost index for all districts is close to unity and varies from 0.785 to 1.196. This indicates that the lowest cost district(s) pay 21.5% less, while the highest cost district(s) pay 19.6% more, than the average district to provide a given level of personnel and transportation services. Moreover, CITY AND SUBURBAN DISTRICTS pay about 9% higher than average costs while RURAL DISTRICTS pay about one percent lower than average costs. The KANSAS CITY and ST. LOUIS METROPOLITAN AREAS exhibit about seven to ten percent higher than average costs, respectively, while ALL OTHER REGIONS taken together exhibit just over one percent below average costs. All of these results are consistent with the expectation that metropolitan areas will tend to incur higher costs of educational services due to higher costs of living and greater competition in markets for school personnel.

Administrators' costs tend to exhibit a much wider variation than teachers' costs and hence tend to widen the variation in the overall cost index somewhat. On the other hand, inclusion of the transportation cost index in the overall cost index tends to reduce the variation since transportation costs tend to be relatively lower in the metropolitan areas while personnel costs in metropolitan areas tend to be relatively high. In fact the transportation cost index is negatively correlated with both the teacher and administrator salary indices (i.e., correlations were -.56 in both cases). The lower costs of transportation services in metropolitan areas are primarily associated with the fact that a smaller percentage of children are transported, the density of student populations is greater, and districts are larger in urban and suburban relative to rural settings.

V. IMPLICATIONS FOR STATE AID ALLOCATIONS

A general computer simulation of alternative school aid formulas developed for the Missouri educational finance project was used to indicate the impact of including a cost-of-education index in the allocation of state aid to each of the 559 school districts in the state. The actual aid formula used is fairly detailed but is essentially a foundation type of aid formula with a guaranteed tax base (GTB) formula for districts spending above the foundation level.[8] That is, all school districts must spend a minimum amount per pupil (the foundation level) with the state aid share varying inversely with the local tax base (property value per pupil). Above the foundation amount, the state guarantees a particular property value (the guaranteed tax base level) available for taxing via a locally set property tax rate when the actual local property tax base is below the guaranteed level.

For the prupose of compensating local school districts for variations in education costs, there are a number of ways in which the educational cost index may be applied. The impacts of two alternatives are illustrated in Table 5: application to state aid payments only and application to the foundation and GTB elements of the formula. The levels of aid or foundation and GTB levels in each case simply are multiplied by the cost index calculated previously for each district. Ceteris paribus, more state aid flows to districts with an index above 1.0 and less to districts with an index below 1.0.[9]

Simulations of the alternative methods of applying the index indicate that application of the cost index will cost the state additional aid money no matter how it is applied. For example, application of the index to the amount of state aid results in a more than 3.4% increase in total state aid, while application to the foundation and guaranteed tax base expenditures (i.e., for the most part, total expenditures of the district) would mean an

TABLE 5

SIMULATED IMPACT OF USING A COST-OF-EDUCATION INDEX IN ALLOCATING STATE AID IN MISSOURI, 1977-78[a]

Cost Index	Change in Total State Aid (Millions)	Simulated Expenditures Per Pupil		
		Central City Districts	Suburban Districts	Rural Districts
None	---	$ 1408	$ 1269	$ 1230
Applied to State Aid	$ 12.5	1423	1282	1229
Applied to Foundation Level and GTB	27.0	1442	1295	1228

[a]This simulation assumes a foundation level of $849 per pupil (with a $2.04/$100 deduction tax rate) and a guaranteed tax base (GTB) of $23,800 per pupil.

Source: Based on the cost index developed for Table 4 and the simulation model in Odden and Vincent [15].

increase of over 6.7% in total state support of educational spending. The reason for the overall increase in state aid is that the index levels in the more populous metropolitan areas tend to be above 1.0. Even though the average cost index over all districts is essentially 1.0, the per pupil basis of aid formulas will mean more money based on the greater numbers of pupils in the above-average-cost districts.

On the whole, both central city and suburban districts would gain on average from one to two percent in expenditures per pupil while rural districts would stay about the same. But the major central city districts of Missouri, St. Louis and Kansas City, would gain even more since they lie at the upper ends of the distributions of the cost indices within their respective metropolitan areas.

One issue which arises in the context of implementation of an educational cost index relates to how often the index would have to be recalculated over time. If, for example, the estimates of the index are relatively stable from one year to the next, then it will not be necessary to recalculate the index each year. To investigate the stability of the index over time, an alternative form of the teachers' salary index was estimated for both the 1974-75 and 1975-76 school years using different random samples of teachers for both years.[10] The correlation between the two salary indices is .9446. These results suggest that there is a reasonable level of stability in the index between the two years. Although further work needs to be done on this issue, these results do indicate that it might not be necessary to recalculate the cost index on a yearly basis.

VI. CONCLUDING REMARKS

Recent court decisions in several states (e.g., the Serrano case in California) have directed the state legislatures to reformulate state aid programs to make school spending less dependent upon the property wealth of local

school districts. However, proponents of these equalization efforts have noted that such adjustments in state aid formulas may not be sufficient: that instead, equality of educational inputs (e.g., class size, teacher characteristics, and supplies and materials) or even equality of educational outcomes should be the goal.

Evidence presented in this paper suggests that a dollar of educational spending will not purchase identical levels of educational inputs across local school districts within a fairly diverse state. The estimation of behavioral equations for the various components of educational expenditure (i.e., teachers, administrators, and transportation services) has been suggested as one approach to determining the variations in educational costs across local school districts. This current effort is but a first attempt to estimate these variations in educational costs and to determine the impact on state aid allocations for education.

Further research using more detailed and comprehensive sets of data on teacher attributes and characteristics of schools and school districts will be necessary to confirm the results reported in this paper. Moreover, further research on personnel costs should investigate possible differences in the parameters of the market price schedules across submarkets (e.g., male/female, black/white, and metropolitan/nonmetropolitan labor markets).

One important issue which we have avoided in this paper is any sort of systematic separation of the endogenous from the exogenous variables. For example, some have argued that teacher experience does not contribute to the quality of educational services, and, therefore, any increase in teachers' salaries associated with increased experience should properly be treated as an increase in the cost, rather than an increase in the quality, of teachers' services. Those who usually make this argument cite the educational production function literature which reveals no consistent relationship between

teacher experience and pupil performance (see Averch et al. [2]). Given the rather primitive state of the art of social science research on the educational production process and the rather limited measures of educational outcomes that have been used in such studies, one would have to be rather skeptical as to judgments about educational quality that rely entirely on this literature.

An alternative approach to the determination of the characteristics of which teacher quality consist would be to observe the revealed preferences of local school decision makers by examining the systematic patterns of employment of teacher attributes across districts. Valued traits will tend to reveal systematic variations in employment in response to variations in school input prices and educational budgets across districts. There is some evidence that teacher experience is a valued trait, but that, due to constraints on the choice of teacher traits imposed by tenure and seniority provisions of state laws or union contracts, some districts find themselves employing more experience than they would otherwise desire. The empirical issue becomes one of determining the degree to which the experience employed by a district is in excess of that that would be employed in the absence of seniority and tenure provisions.[11]

Much of the discussion of developing geographic cost-of-education indices in the education finance literature has focused on equity issues -- the provision of at least equalized resources to districts (i.e., real rather than nominal dollars) no matter where located. However, there may be negative efficiency implications in the long run of providing compensation for cost differences: it is conceivable that economically inefficient locational decisions could be encouraged for both households and firms. It might be argued that application of the index to state aid alone rather than essentially total

expenditures would compensate in terms of dollars raised at the state-wide level from taxpayers across all districts. Then, the locally financed portions of education spending would bear the burden of the higher location costs. On the other hand, viewing this issue in terms of concerns of central city officials over the financial impact of business and white resident flight to the suburbs, the use of such an index could mitigate the problems of groups more or less confined to central city locations. And insofar as elements of the index take into account a "taste for discrimination," it is difficult to claim that locational inefficiencies are involved.

The tradeoffs of equity and efficiency in policy analysis are well-known. And the final decision on use of the index has an important political dimension since central city and some adjacent suburban districts will gain while other suburban and rural districts will tend to lose aid.

In any case, a similar cost index is now being developed for California that will be used in a manner that has not been feasible thus far: the estimation of demand-for-education and expenditure-per-pupil equations. For example, school district expenditures will be related not only to an array of direct fiscal variables (e.g., average income, percentage of property value that is residential) and other socioeconomic variables (e.g., pupil growth rates, educational level of the adult population), but also to underlying costs of education. Writers in this area have not yet had such information available.

The development of cost indices of the sort discussed here is difficult indeed. Although some efforts to develop either an index for the U. S. as a whole or individual state indices from readily available data are underway, the approach suggested here is to focus primarily on detailed characteristics of individual teachers and other personnel. A close examination of factors existing in the individual state markets and submarkets is necessary. At the same time, the techniques utilized here could be applied to a variety of

industries in both the public and private sectors as well as, perhaps, in taking into account locational preferences in the distribution of transfer payments.

APPENDIX

VARIABLE NAMES AND DEFINITIONS

Variable Names

Analysis of Personnel Costs

TCHR SAL	annual teacher's salary
ADMIN SAL	annual administrator's salary
EDUC NO BA	=1 if no B.A. degree has been earned
EDUC BA	=1 if B.A. is highest degree
EDUC 15-29 GRAD HRS	=1 if earned 15-29 grad. hrs.
EDUC 30-44 GRAD HRS	=1 if earned 30-44 grad. hrs.
EDUC 45-59 GRAD HRS	=1 if earned 45-59 grad. hrs.
EDUC 60 OR MORE GRAD HRS	=1 if earned 60 or more grad. hrs.
EDUC MA	=1 if Masters is highest degree
EDUC ED SPEC CERT	=1 if Educ. Spec. Cert. is highest degree
EDUC DOC	=1 if Doctorate is highest degree
EXP TOTAL YRS	total years of experience
$(\text{EXP TOTAL YRS})^2$	total years of experience--squared
EXP PRESENT DIST	years of experience in present district
$(\text{EXP PRESENT DIST})^2$	years of experience in present district--squared
MATH-SCI TCHR	=1 if a math or science teacher
PHYS EDUC TCHR	=1 if a physical education teacher
BUS EDUC TCHR	=1 if business education teacher
VOC EDUC TCHR	=1 if vocational education teacher
ELEM TCHR	=1 if elementary teacher
ELEM PRIN OR ASST PRIN	=1 if elementary or assistant elementary principal
JR HIGH SCH ASST PRIN	=1 if a jr. high school assistant principal
JR HIGH SCH PRIN	=1 if a jr. high school principal
HIGH SCH ASST PRIN	=1 if high school assistant principal
HIGH SCH PRIN	=1 if a high school principal
ELEM SUPV	=1 if an elementary supervisor
JR HIGH SCH SUPV	=1 if a jr. high school supervisor
HIGH SCH SUPV	=1 if a high school supervisor
VOC EDUC SUPV	=1 if a vocational education supervisor
GENERAL SUPV	=1 if a general supervisor
ELEM DIRECTOR	=1 if an elementary director
CONFINED TO GEOG. LOC--YES	=1 if confined to geographic location by spouse's employment
CONFINED TO GEOG. LOC--NO	=1 if not confined by spouse's employment
CLASS HOURS	number of class hours taught
SEX--MALE	=1 if male
SEX--FEMALE	=1 if female
FAMILY INCOME	median family income in local community
ELEM DIST--YES	=1 if employed in elementary district
ELEM DIST--NO	=1 if employed by unified district
PERCENT BLACK PUPILS	percent of black pupils in district
PERCENT REMED. READ. PUPILS	percent of pupils enrolled in remedial reading in district
DIST SIZE	number of pupils in the district, proxy for average daily membership
DIST. DENSITY, REGION	number of districts per square mile in the region in which the district is located
POP. DENSITY, COUNTY	population per square mile in the county in which the district is located
PRICE AGRI LAND	price per acre of agricultural land in the county in which the district is located

Analysis of Transportation Costs

TOTAL TRANS EXPEND	total expenditures on transportation services
MILEAGE/PUPIL	mileage traveled per pupil transported
AVG DAILY PUPILS TRANS	average daily number of pupils transported
CONTRACTED AVG DAILY PUPILS TRANS	average daily number of pupils transported by private contractors
PERCENT URBAN POP. IN COUNTY	percent of population in the county living in urban areas
PUPILS/SQ. MI.	number of pupils per square mile in the district
DIST SIZE	number of pupils in the district
PERCENT CHG IN DIST SIZE	percent change in the number of pupils in the district between the 1974-75 and 1975-76 school year
INCHES OF SNOW	actual number of inches of snowfall during the 1975-76 school year in the climatic region in which the district is located

FOOTNOTES

[1]Florida, for example, has developed an elaborate cost-of-living survey for its school districts, but the basis for the determination of this cost-of-living index is quite different from the analysis presented in this paper.

[2]A number of other variables were tried for the analysis of teachers' salaries, but none was statistically significant. Some of these variables were: quality of college attended for undergraduate degree, percentile rank on the verbal section of the SAT or GRE tests (teachers were asked on the personnel survey to recall their scores on these tests), race, a proxy for class size, age, and father's education. Some of the difficulties associated with isolating the effects of these variables might be related to relatively small response rates for portions of the survey, small numbers of individuals within the particular category (e.g., there were less than 3% black teachers), and/or the current surplus which appears to characterize the teachers' market. Family income in the community might well be regarded as exogenous to district decision making and hence be included as a cost (exogenous) factor. However, a priori one might expect that if teacher characteristics had been adequately controlled for in the equation, a negative relationship would have been found, i.e., teachers would give up wages to work in wealthier districts. The positive coefficient seems more consistent with the explanation that wealthier districts buy better "quality" teachers. Therefore, family income is not treated as a cost factor.

[3]See Kenny, Denslow, and Goffman [13] and Tolley [19] for discussions of the issues of measuring cost-of-living differentials across regions.

[4]To identify regional labor markets within Missouri, it was necessary to examine maps showing population density, various centers of economic and

business activity, the kinds of industry, differences in geography, and the network of major highways and roads that connect the cities and towns. The interested reader may obtain a map showing these regional boundaries upon request.

[5]This results is consistent with previous work on this issue. See, for example, Kenny, Denslow, and Goffman [13].

[6] Isolation of regional bargaining effects as a cost factor (i.e., one which may be exogenous to local districts) does not necessarily imply that the state ought to compensate districts for higher costs associated with bargaining. Indeed, policy makers may decide that whatever the circumstances under which bargaining gains were made, the state ought not to reimburse districts for higher costs incurred. However, more work on the nature and extent of bargaining effects should be carried out before this issue is finally settled.

[7]There are a number of alternative ways of specifying the endogenous versus exogenous variables for determination of transportation costs. The index used in the text is simply one alternative. However, it is doubtful that most of the reasonable alternatives would yield substantially different results particularly in view of the fact that transportation expenditures account for 5.17% of average district budgets. One other alternative which is possible would be to treat transportation cost separately from the rest of the school budget.

[8]Basic elements of the simulation model upon which the following discussion is based are described in Odden and Vincent [15] , especially Chapter 2 and Appendix C.

[9]The district response model utilized for the finance simulations assumes that the district will utilize all additional state aid funds to increase education spending, i.e., local property tax rates remain unchanged. However, it is likely that some unrestricted funds will be used for local property tax reduction.

[10]Data limitations over the two-year period prevented estimation of the same equation specified in Table 1. Instead of the specification of the size, density, and price of agricultural land variables used in Table 1, a set of regional dummy variables along with dummy variables indicating type of district (i.e., central city, suburban, rural) and size of district were used for both years. It should be noted that this alternative formulation correlated highly (.89) with the specification presented in Table 1 of this paper.

[11]For a complete discussion of the behavioral approach and of some emprical evidence on these issues, see Chambers [7].

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